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Hirotoomi et al.

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- (54) **BICYCLE RIM BRAKE**
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- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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- (22) Filed: **Mar. 9, 2015**

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B62L 1/14 (2006.01)
B62L 3/02 (2006.01)
- (52) **U.S. Cl.**
CPC .. **B62L 1/14** (2013.01); **B62L 3/023** (2013.01)
- (58) **Field of Classification Search**
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B62L 3/023; B60T 11/16; B60T 11/20;
B60T 8/4095
USPC 188/24.11–24.22, 152, 344
See application file for complete search history.

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(57) **ABSTRACT**

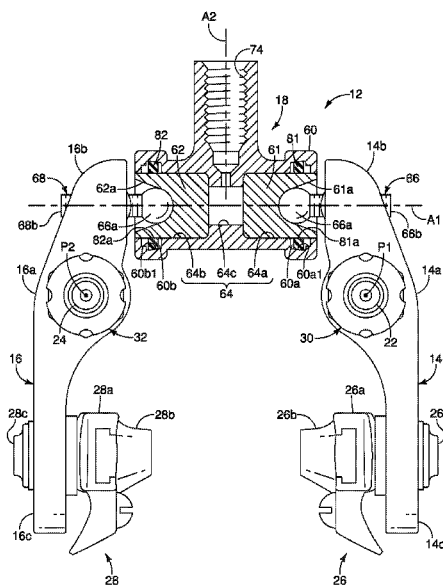
A bicycle rim brake is basically provided with first and second brake arms and a hydraulic actuation device. The first brake arm has a first coupling portion, a first actuated portion and a first mounting portion. The first coupling portion includes a first mounting fastener defining a first pivot axis of the first brake arm. The first mounting portion mounts a first friction member. The second brake arm has a second coupling portion, a second actuated portion and a second mounting portion. The second coupling portion includes a second mounting fastener defining a second pivot axis of the first brake arm. The second mounting portion mounts a second friction member. The hydraulic actuation device includes first and second pistons movably disposed in a cylinder housing and operatively coupled to the first and second actuated portions on the first and second brake arms, respectively.

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19 Claims, 12 Drawing Sheets



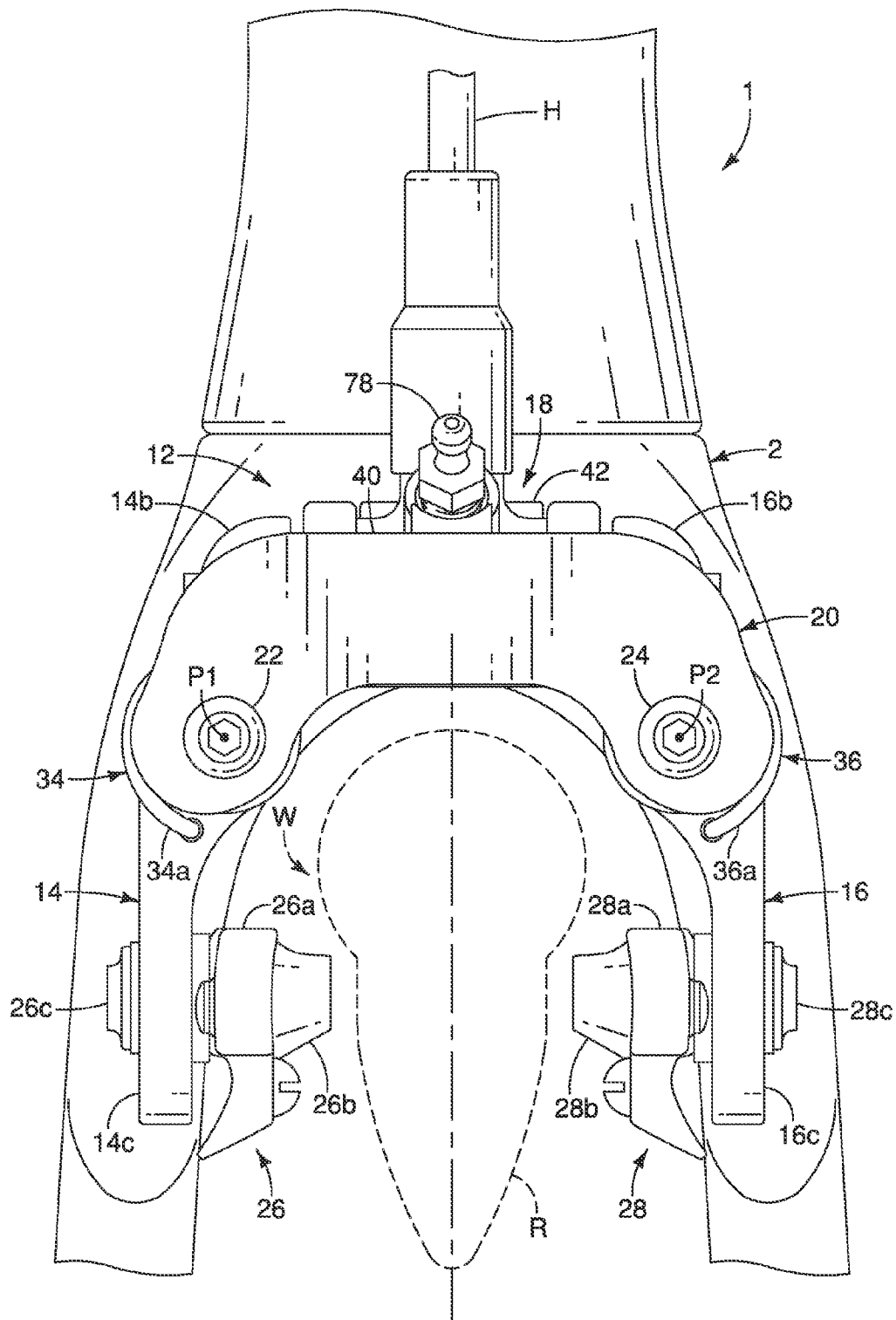


FIG. 1

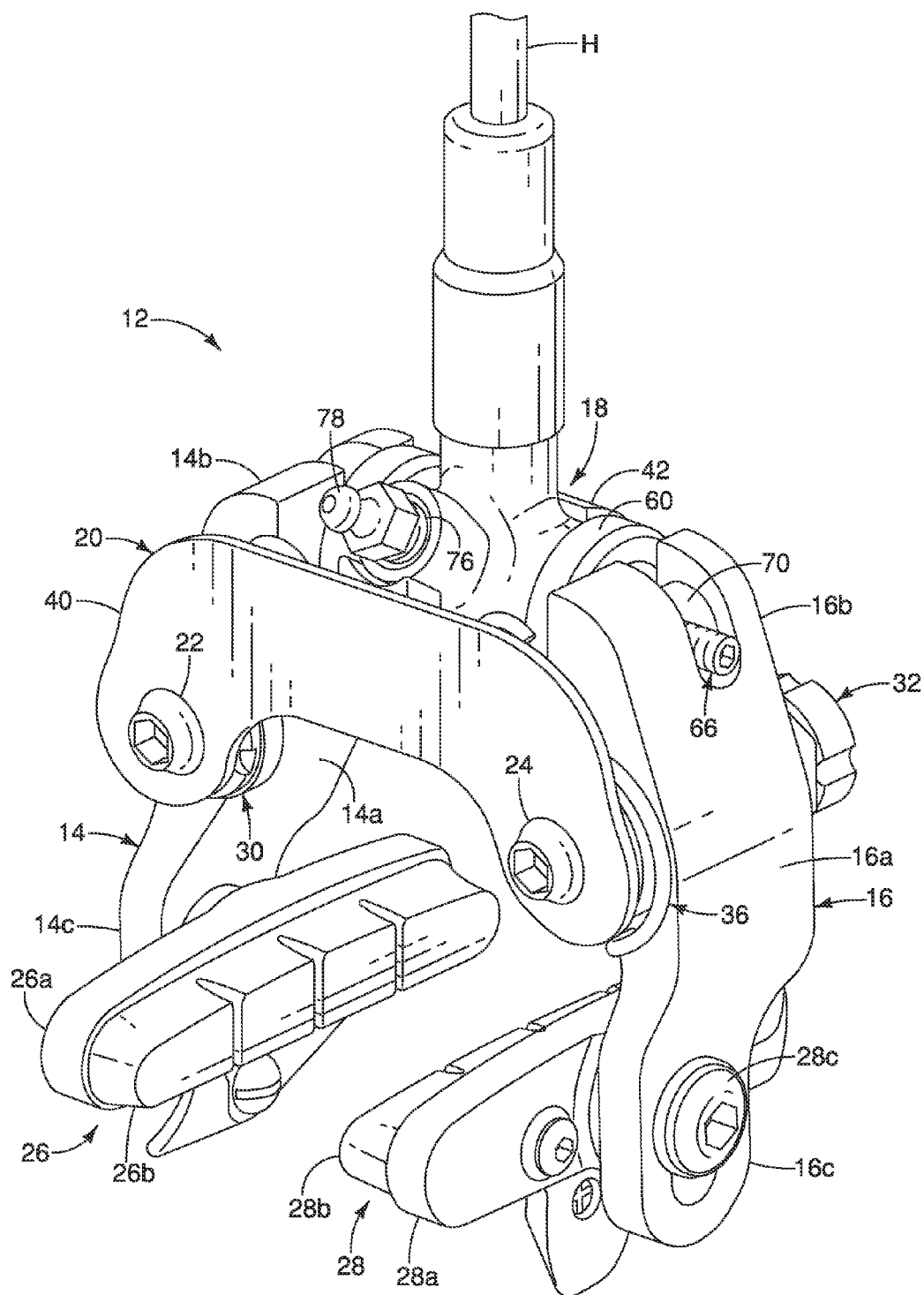


FIG. 2

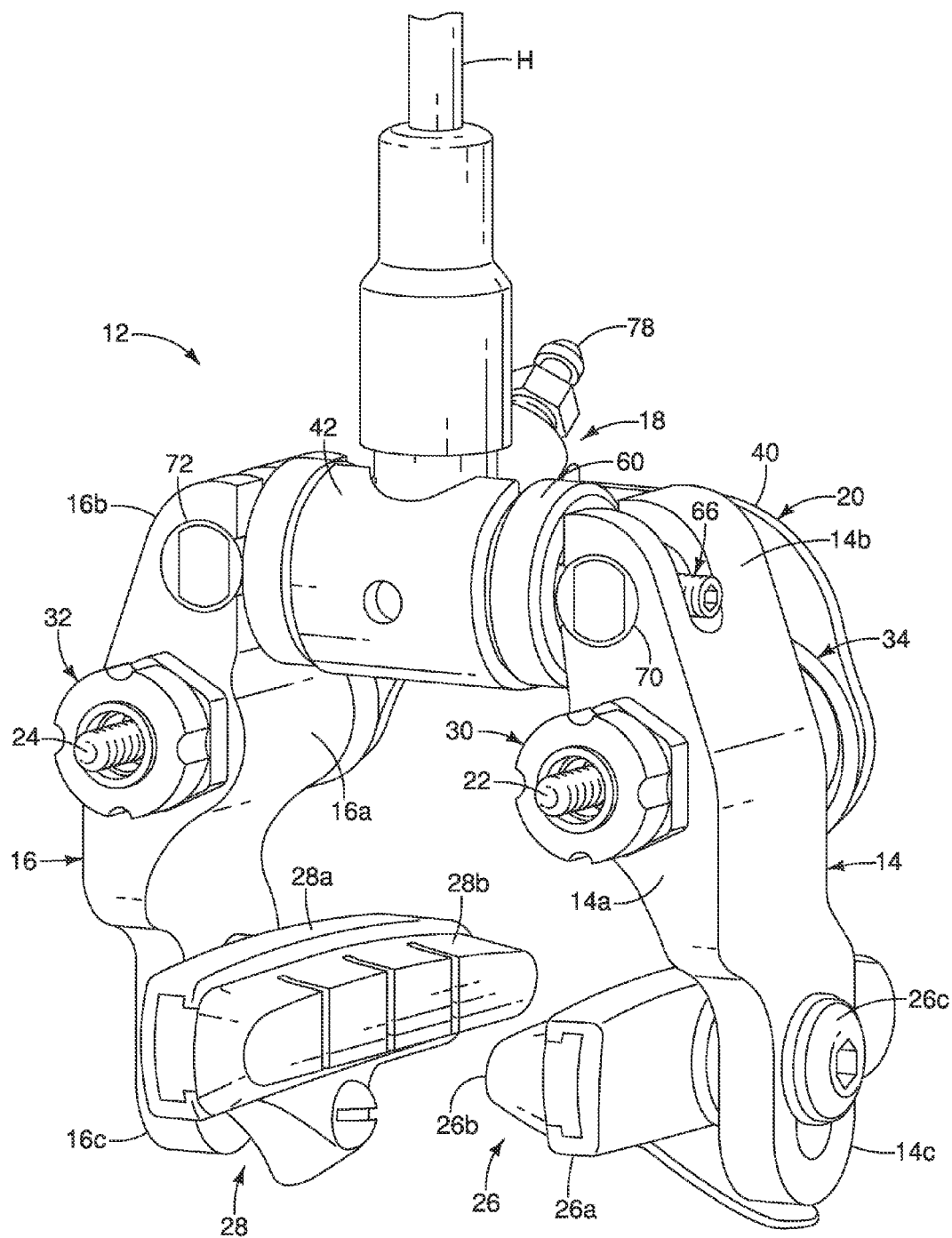


FIG. 3

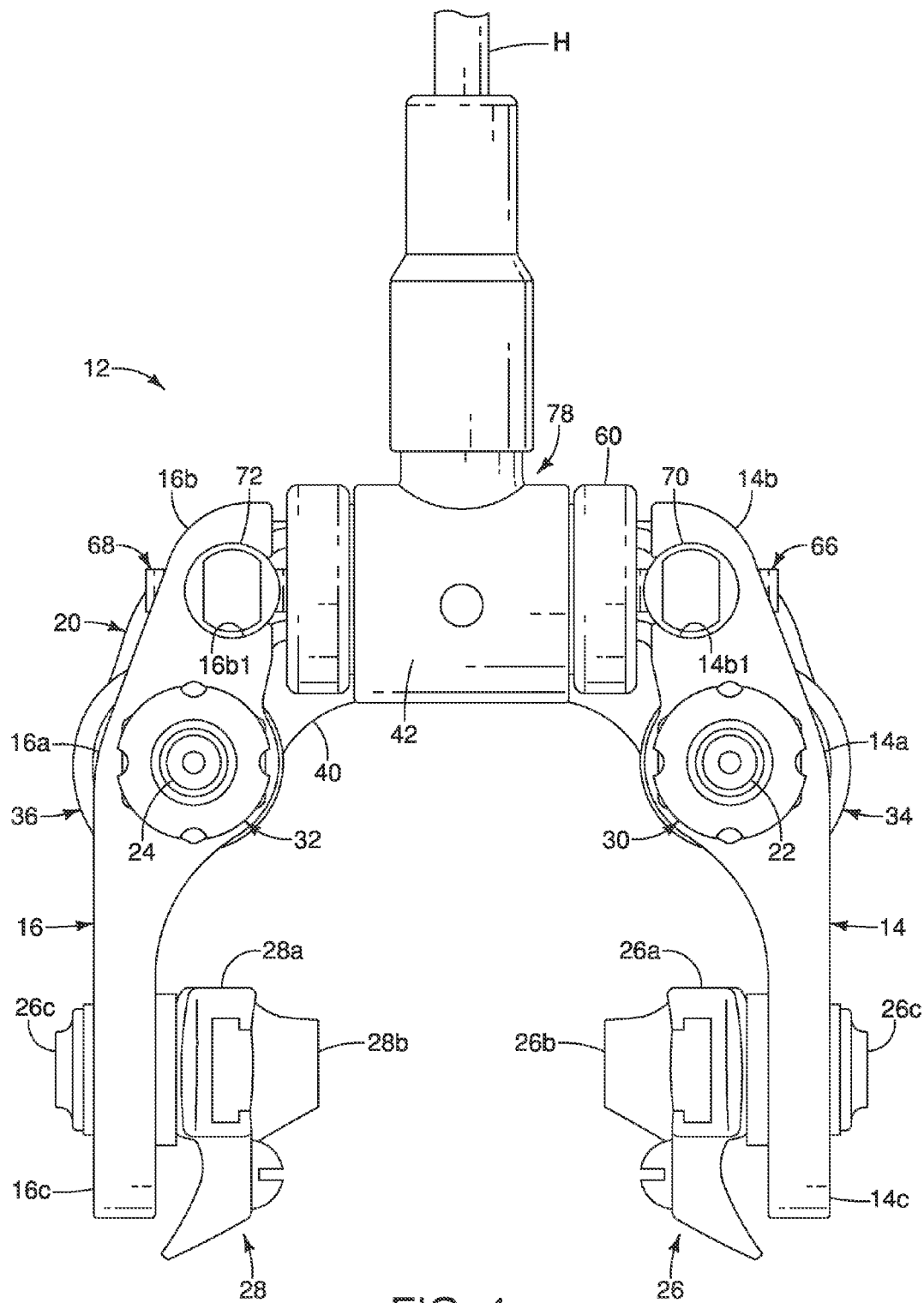


FIG. 4

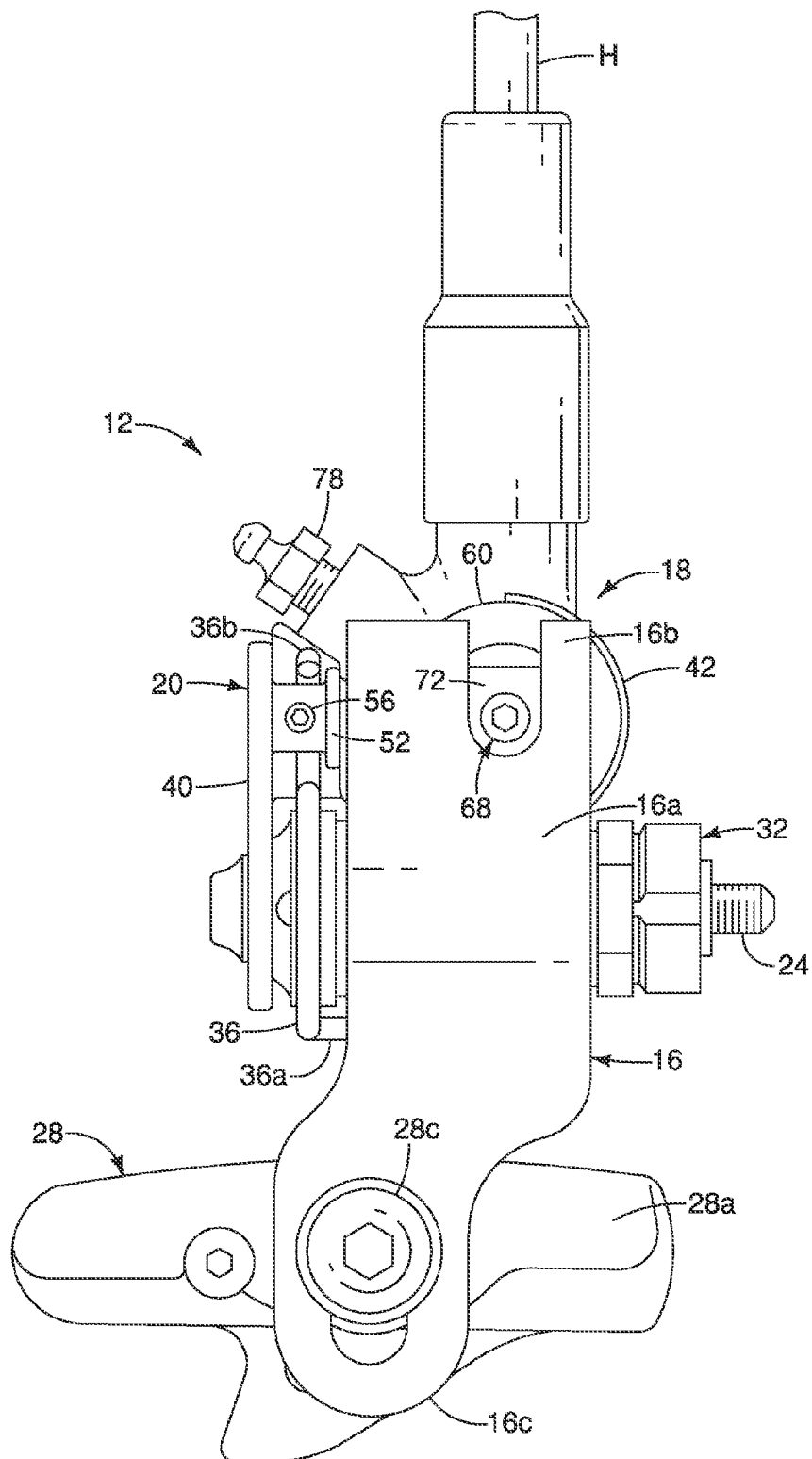


FIG. 5

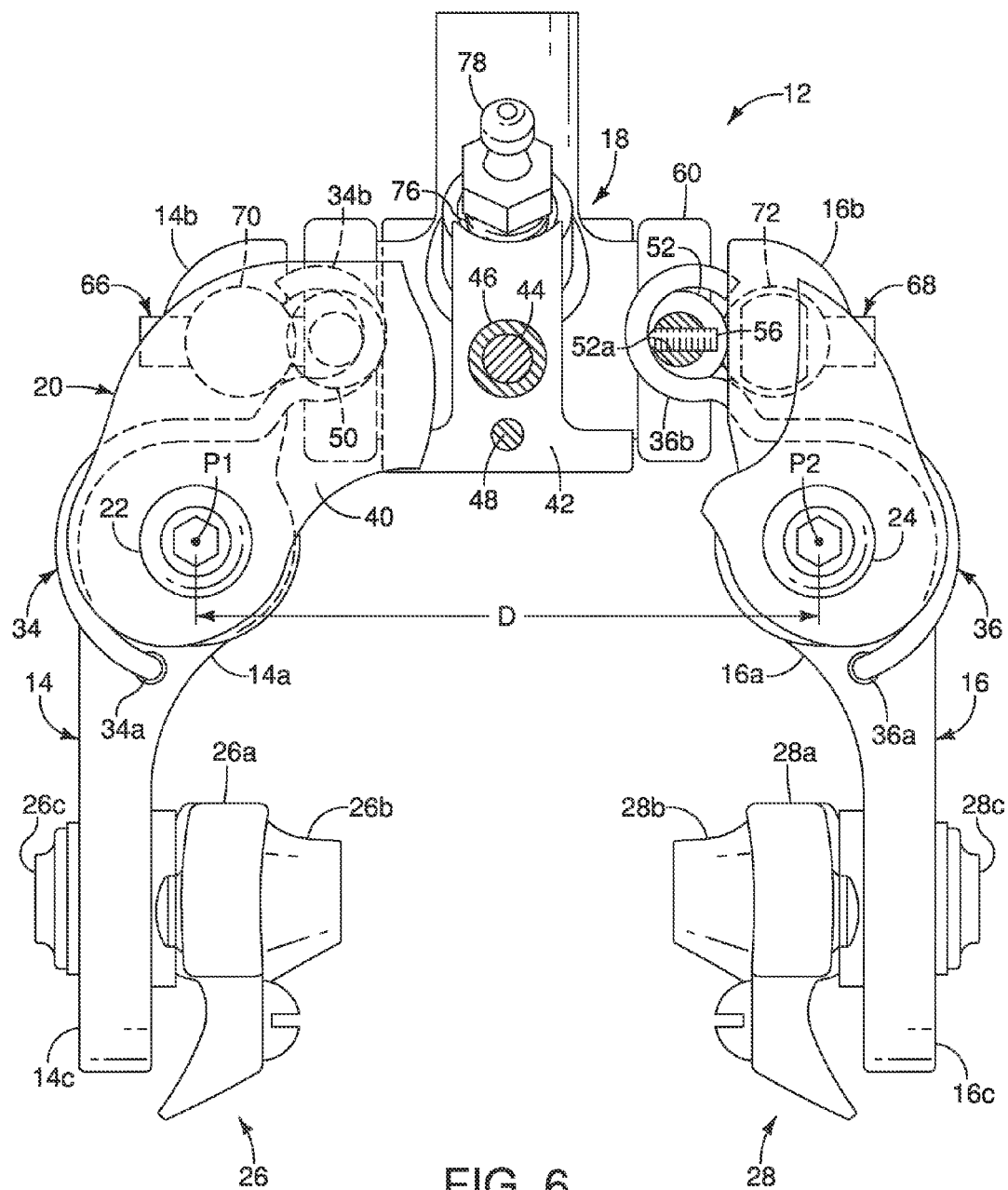


FIG. 6

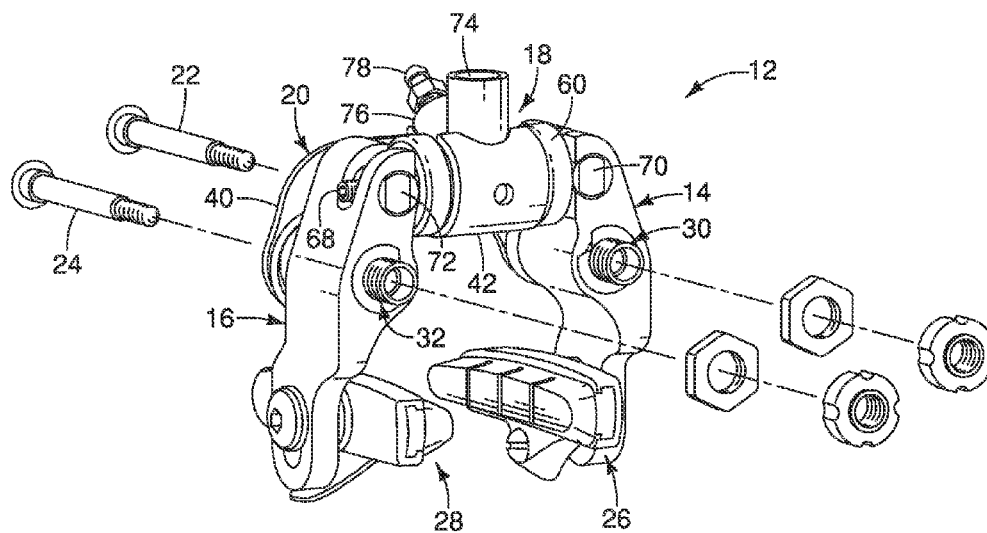


FIG. 7

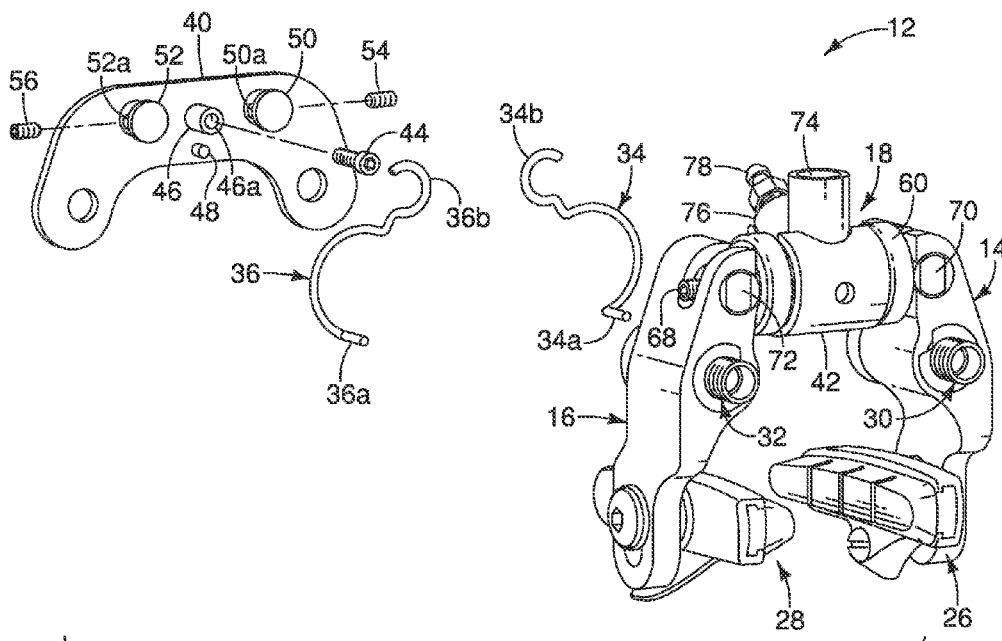


FIG. 8

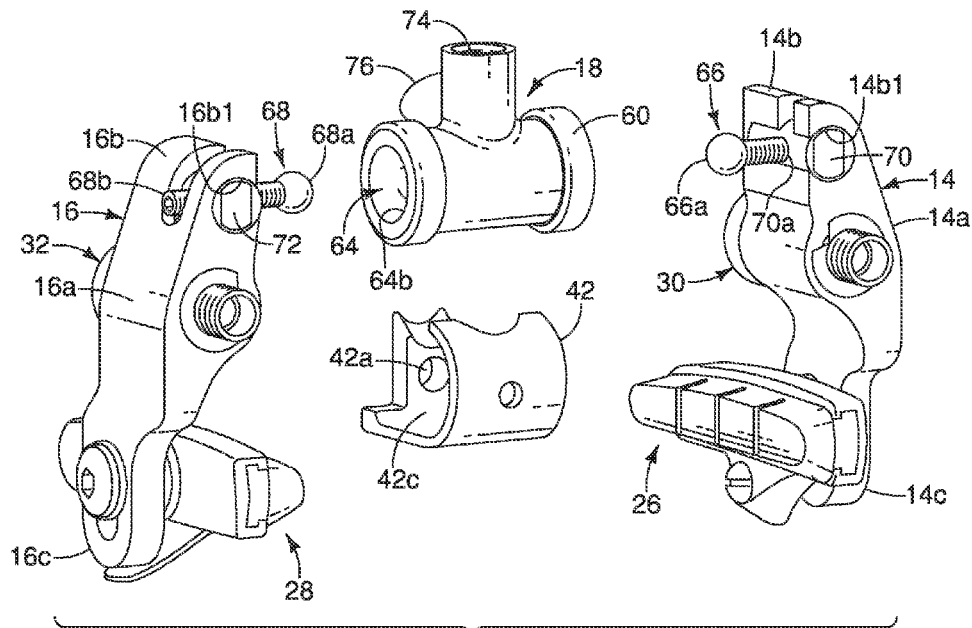


FIG. 9

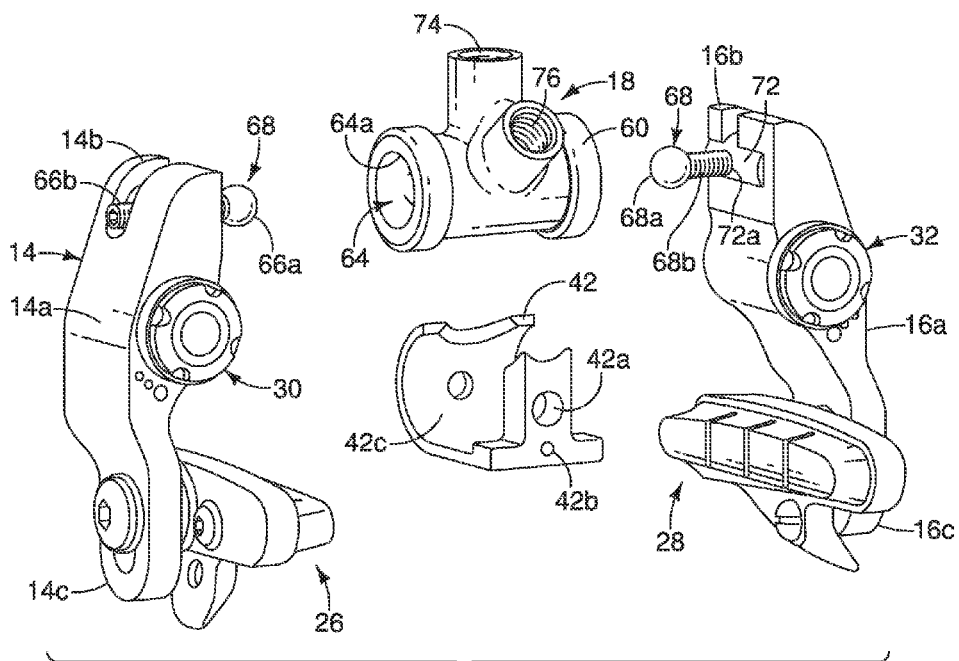


FIG. 10

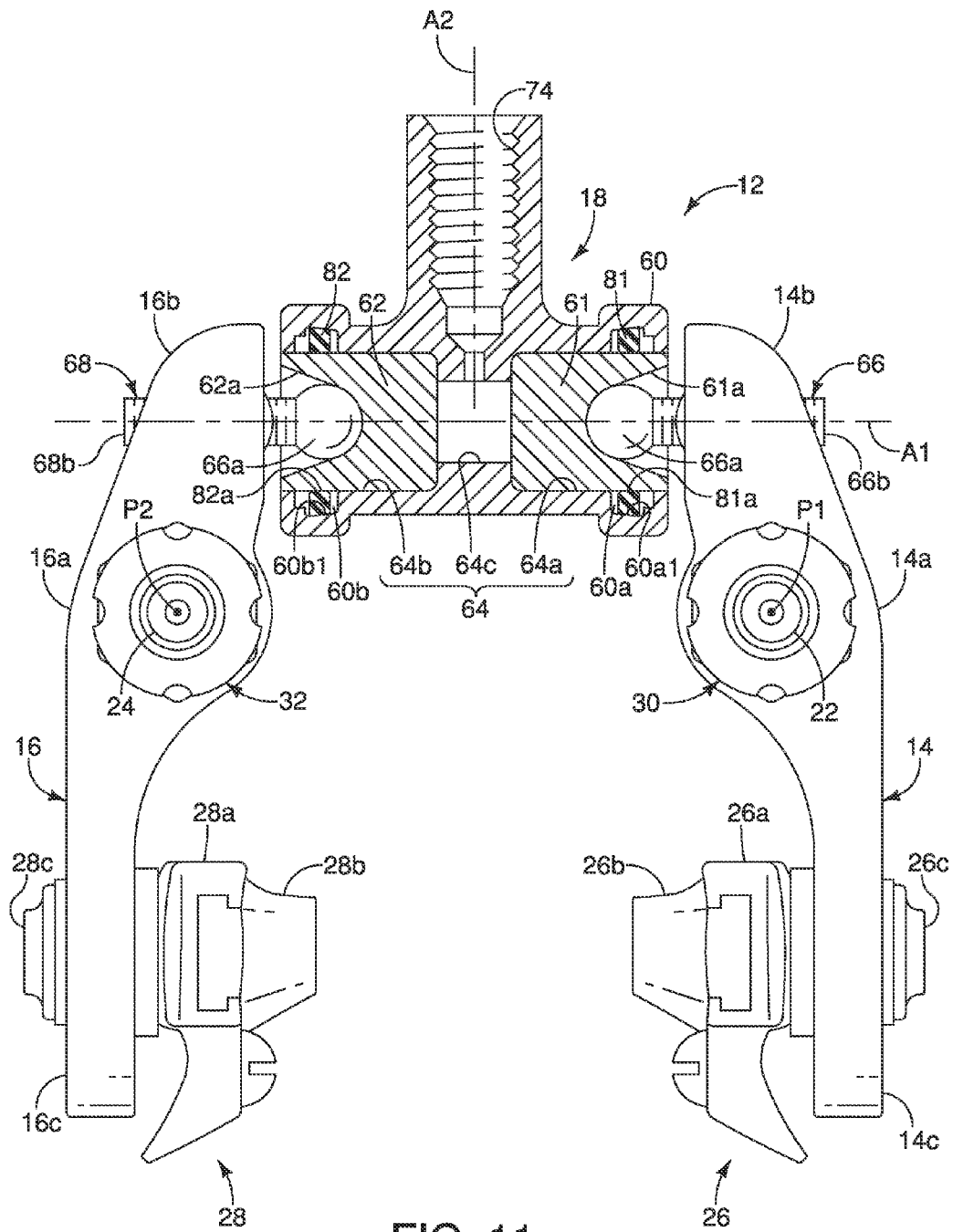


FIG. 11

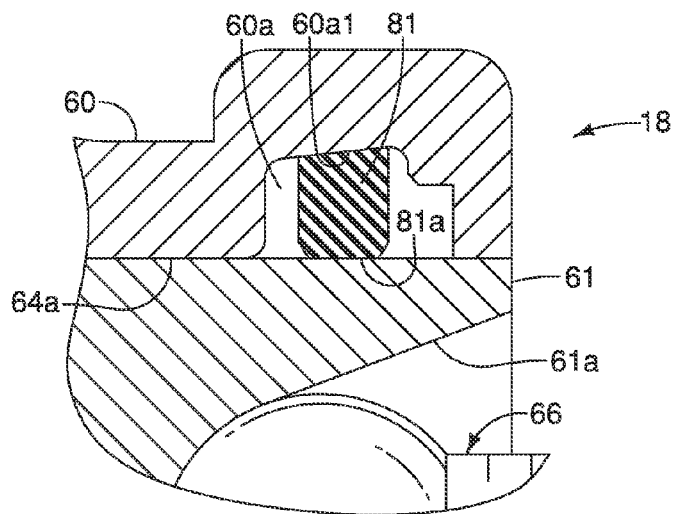


FIG. 12

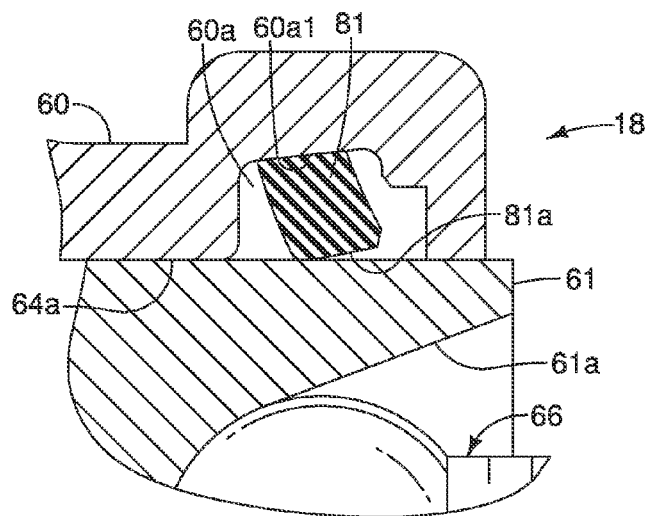


FIG. 13

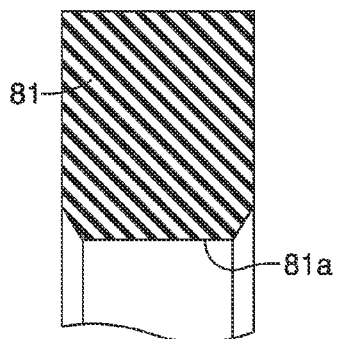


FIG. 14

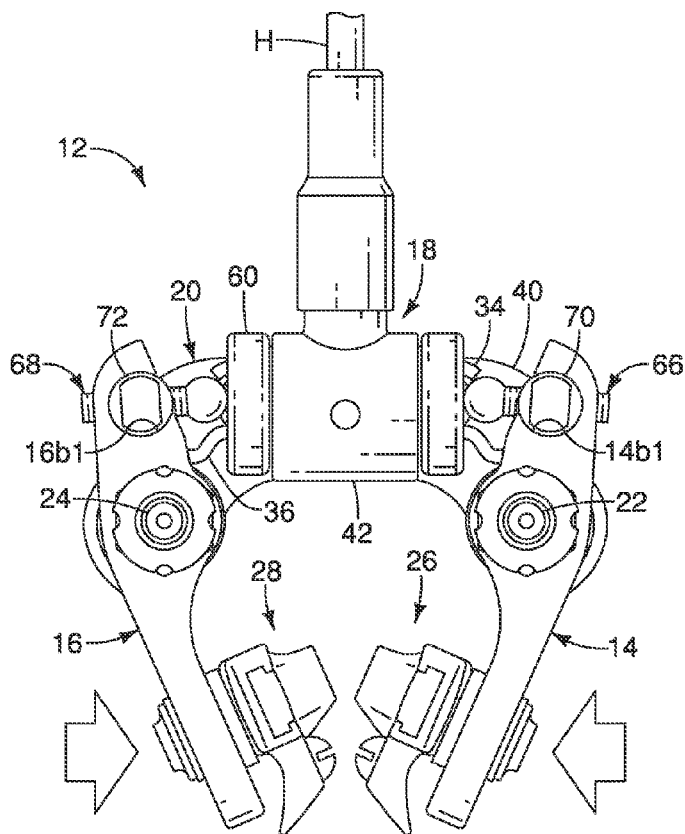


FIG. 15

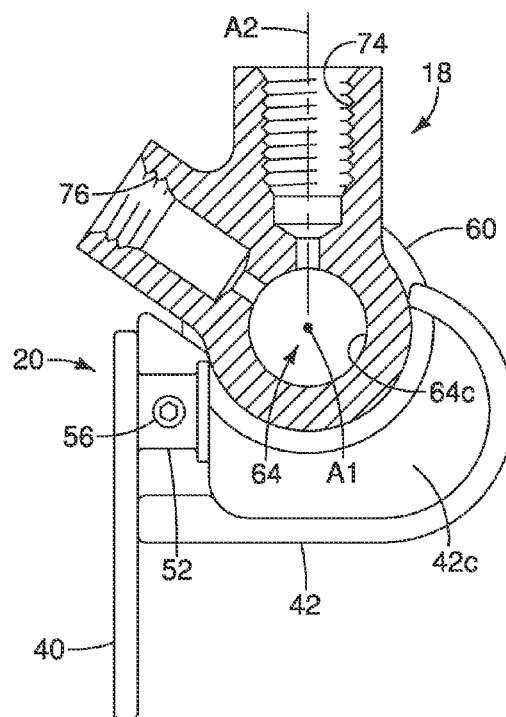


FIG. 16

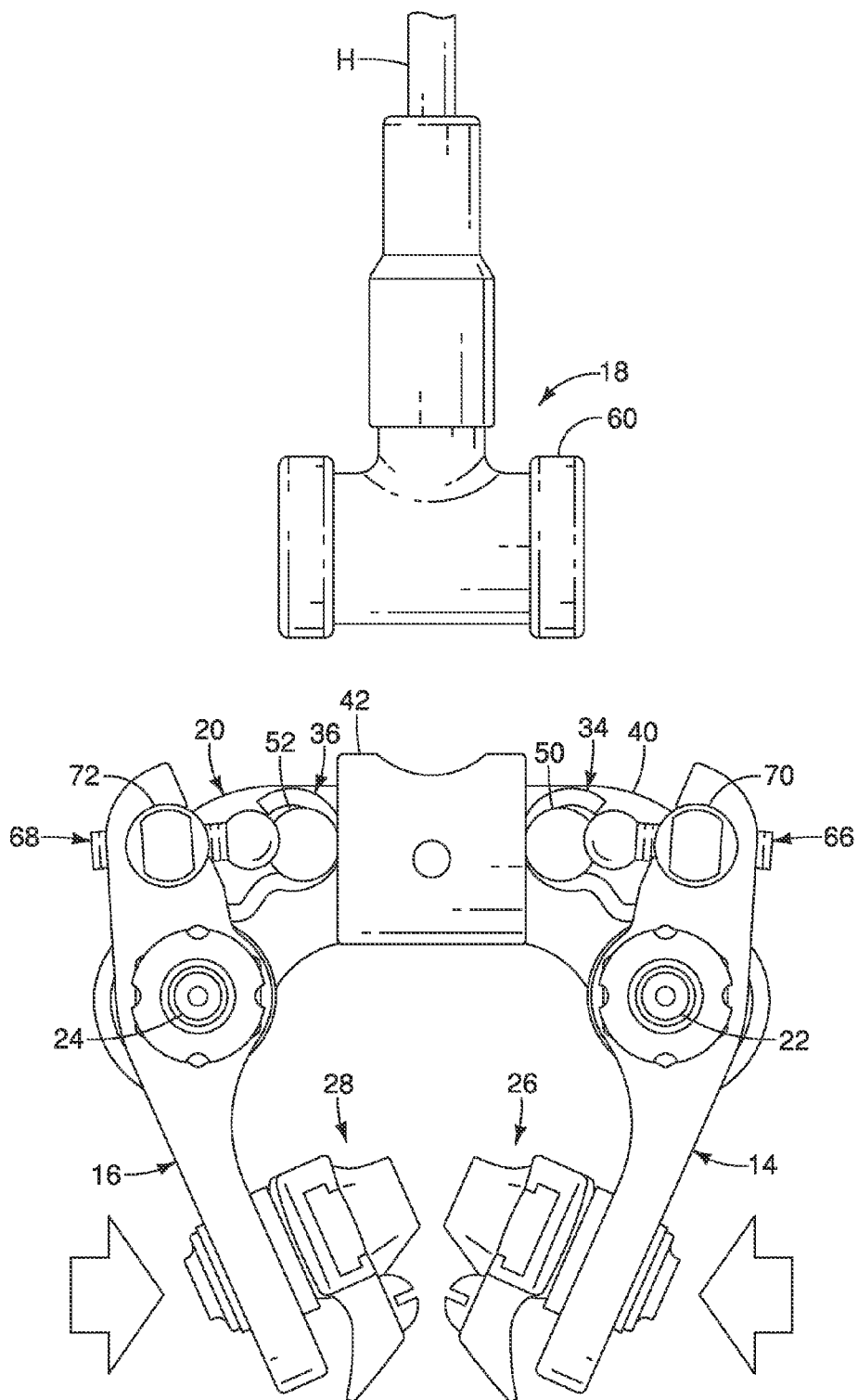


FIG. 17

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BICYCLE RIM BRAKE**BACKGROUND****1. Field of the Invention**

This invention generally relates to a bicycle rim brake. More specifically, the present invention relates to a bicycle rim brake that includes a hydraulic actuation device for applying an actuating force to move first and second brake arms to a braking position.

2. Background Information

Bicycles are typically provided with at least one brake device for stopping. Currently, a wide variety of bicycle brake devices are available. One popular type of bicycle brake device is a rim brake. Rim brakes are configured to apply a braking force to the wheel of a bicycle by pinching the rim of the wheel with a pair of brake shoes attached to a pair of brake arms. Rim brakes are available in several configurations. For example, rim brakes include a side pull type, a center pull type and a dual-pivot. Examples of rim brakes are disclosed in U.S. Pat. No. 7,677,365, which is assigned to Shimano Inc. These rim brakes are operated using a Bowden cable. More recently, hydraulically operated rim brakes have been proposed.

SUMMARY

Generally, the present disclosure is directed to various features of a bicycle rim brake. In one feature, a bicycle rim brake is provided in which a hydraulic actuation device is provided with two pistons for actuating the brake arms.

In view of the state of the known technology and in accordance with a first aspect of the present disclosure, a bicycle rim brake is provided that basically comprises a first brake arm, a second brake arm and a hydraulic actuation device. The first brake arm has a first coupling portion, a first actuated portion and a first mounting portion. The first coupling portion includes a first mounting fastener that is configured to be mounted to a bicycle and that defines a first pivot axis of the first brake arm. The first mounting portion is configured to mount a first friction member and extends from the first coupling portion. The second brake arm has a second coupling portion, a second actuated portion and a second mounting portion. The second coupling portion includes a second mounting fastener that is configured to be mounted to a bicycle and that defines a second pivot axis of the first brake arm. The second mounting portion is configured to mount a second friction member and extends from the second coupling portion. The hydraulic actuation device includes a cylinder housing defining a hydraulic chamber, a first piston movably disposed in the hydraulic chamber and operatively coupled to the first actuated portion of the first brake arm, and a second piston movably disposed in the hydraulic chamber and operatively coupled to the second actuated portion of the second brake arm.

In accordance with a second aspect of the present invention, the bicycle rim brake according to the first aspect is configured so that the first actuated portion and the first mounting portion are disposed on opposite sides of the first coupling portion, and the second actuated portion and the second mounting portion are disposed on opposite sides of the second coupling portion.

In accordance with a third aspect of the present invention, the bicycle rim brake according to the first aspect is configured so that the hydraulic chamber includes a first chamber having the first piston disposed therein, a second chamber having the second piston disposed therein, and a third chamber provided between the first and second chambers.

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In accordance with a fourth aspect of the present invention, the bicycle rim brake according to the third aspect is configured so that the third chamber has a smaller diameter than the first and second chambers.

In accordance with a fifth aspect of the present invention, the bicycle rim brake according to the first aspect is configured so that the cylinder housing includes an inlet bore fluidly communicating with the hydraulic chamber at a location between the first and second pistons.

In accordance with a sixth aspect of the present invention, the bicycle rim brake according to the fifth aspect is configured so that the first and second pistons are movable along an actuation axis of the hydraulic chamber, and the inlet bore has a center longitudinal axis that is perpendicularly arranged with respect to the actuation axis of the hydraulic chamber.

In accordance with a seventh aspect of the present invention, the bicycle rim brake according to the first aspect further comprises a first connecting rod having a first end portion connected to the first piston and a second end portion connected to the first actuated portion; and a second connecting rod having a first end portion connected to the second piston and a second end portion connected to the second actuated portion.

In accordance with an eighth aspect of the present invention, the bicycle rim brake according to the seventh aspect is configured so that the first end portion of the first connecting rod is configured to be pivotally coupled to the first piston, and the first end portion of the second connecting rod is configured to be pivotally coupled to the second piston.

In accordance with a ninth aspect of the present invention, the bicycle rim brake according to the first aspect further comprises a support member coupled to the first and second coupling portions and maintains the first and second pivot axes at a prescribed distance apart from each other.

In accordance with a tenth aspect of the present invention, the bicycle rim brake according to the ninth aspect is configured so that the hydraulic actuation device is mounted on the support member.

In accordance with an eleventh aspect of the present invention, the bicycle rim brake according to the first aspect further comprises a first return spring biasing the first brake arm about the first pivot axis towards the first piston.

In accordance with a twelfth aspect of the present invention, the bicycle rim brake according to the eleventh aspect further comprises a first adjustment member arranged to adjust a biasing force of the first return spring.

In accordance with a thirteenth aspect of the present invention, the bicycle rim brake according to the eleventh aspect further comprises a second return spring biasing the second brake arm about the second pivot axis towards the second piston.

In accordance with a fourteenth aspect of the present invention, the bicycle rim brake according to the thirteenth aspect further comprises a second adjustment member arranged to adjust a biasing force of the second return spring.

Also other objects, features, aspects and advantages of the disclosed bicycle rim brake will become apparent to those skilled in the art from the following detailed description, which, taken in conjunction with the annexed drawings, discloses one embodiment of the bicycle rim brake.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the attached drawings which form a part of this original disclosure:

FIG. 1 is a front elevational view of a portion of a bicycle equipped with a bicycle rim brake in accordance with a first

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embodiment, with the bicycle rim brake being in a non-braking position or resting position;

FIG. 2 is a front perspective view of the bicycle rim brake illustrated in FIG. 1 with the bicycle rim brake being in the non-braking position;

FIG. 3 is a rear perspective view of the bicycle rim brake illustrated in FIGS. 1 and 2 with the bicycle rim brake being in the non-braking position;

FIG. 4 is a rear elevational view of the bicycle rim brake illustrated in FIGS. 1 to 3 with the bicycle rim brake being in the non-braking position;

FIG. 5 is a side elevational view of the bicycle rim brake illustrated in FIGS. 1 to 4 with the bicycle rim brake being in the non-braking position;

FIG. 6 is a front elevational view of the bicycle rim brake illustrated in FIGS. 1 to 5 with a portion of the support member of the bicycle rim brake broken away to reveal the spring arrangement;

FIG. 7 is a partially exploded perspective view of the bicycle rim brake illustrated in FIGS. 1 to 6;

FIG. 8 is another partially exploded perspective view of selected parts of the bicycle rim brake illustrated in FIGS. 1 to 6;

FIG. 9 is another partially exploded perspective view of selected parts of the bicycle rim brake illustrated in FIGS. 1 to 6 as viewed from the rear side of the bicycle rim brake;

FIG. 10 is another partially exploded perspective view of selected parts of the bicycle rim brake illustrated in FIGS. 1 to 6 as viewed from the front side of the bicycle rim brake;

FIG. 11 is a front elevational view of the bicycle rim brake illustrated in FIGS. 1 to 6 with portions of the hydraulic actuation device shown in longitudinal cross section;

FIG. 12 is a cross sectional view of a portion of the hydraulic actuation device of the bicycle rim brake illustrated in FIGS. 1 to 6 showing one of the sealing members in a non-actuated position;

FIG. 13 is a cross sectional view of the portion of the hydraulic actuation device illustrated in FIG. 12, but with the piston and the sealing member in actuated positions;

FIG. 14 is an enlarged cross sectional profile of a portion of one of the sealing members of the hydraulic actuation device of the bicycle rim brake illustrated in FIGS. 1 to 6;

FIG. 15 is a rear elevational view of the bicycle rim brake illustrated in FIGS. 1 to 6 with the first and second brake arms held in a position for removing the hydraulic actuation device;

FIG. 16 is a side elevational view of the support member and the holder of the bicycle rim brake illustrated in FIGS. 1 to 6 with the cylinder housing of the hydraulic actuation device shown in cross section and the cylinder housing of the hydraulic actuation device partially remove from the holder of the bicycle rim brake; and

FIG. 17 is a rear elevational view of the bicycle rim brake illustrated in FIGS. 1 to 6 with the first and second brake arms held in the position for removing the hydraulic actuation device and the hydraulic actuation device removed from the holder of the bicycle rim brake.

DETAILED DESCRIPTION OF EMBODIMENTS

Selected embodiments will now be explained with reference to the drawings. It will be apparent to those skilled in the bicycle field from this disclosure that the following descriptions of the embodiments are provided for illustration only and not for the purpose of limiting the invention as defined by the appended claims and their equivalents.

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Referring initially to FIG. 1, a portion of a bicycle 1 having a front fork 2 is illustrated that is equipped with a bicycle rim brake 12 in accordance with a first embodiment. The bicycle rim brake 12 is installed on the front fork 2 such that the bicycle rim brake 12 straddles a bicycle rim R of a front wheel W. Of course, it will be apparent to those skilled in the bicycle field from this disclosure that the bicycle rim brake 12 can be used in conjunction with a rear bicycle wheel.

The bicycle rim brake 12 basically comprises a first brake arm 14, a second brake arm 16 and a hydraulic actuation device 18. In the first embodiment, the bicycle rim brake 12 is hydraulically actuated by a conventional hydraulic actuation device (e.g., a brake lever), which is not shown. The bicycle rim brake 12 further comprises a support member 20. The first and second brake arms 14 and 16 are pivotally supported on the support member 20. In particular, the first brake arm 14 is pivotally supported on the support member 20 by a first mounting fastener 22 that is configured to be mounted to the front fork 2 of the bicycle 1. The first mounting fastener 22 defines a first pivot axis P1 of the first brake arm 14. Similarly, the second brake arm 16 is pivotally supported on the support member 20 by a second mounting fastener 24 that is configured to be mounted to the front fork 2 of the bicycle 1. The second mounting fastener 24 defines a second pivot axis P2 of the first brake arm 14.

As seen from FIGS. 2, 3 and 6, the hydraulic actuation device 18 is mounted on the support member 20. The hydraulic actuation device 18 is fluidly connected to a first end of a hydraulic hose H. The hydraulic hose H further has a second end (not shown) connected to a conventional hydraulic actuating device (not shown). During a braking operation, hydraulic fluid is forced into the hydraulic actuation device 18 causing the hydraulic actuation device 18 to push the first and second brake arms 14 and 16 for applying a braking force to the bicycle rim R.

The hydraulic actuation device 18 is operatively coupled between the first and second brake arms 14 and 16, and arranged to pivot the first and second brake arms 14 and 16 about the first and second pivot axes P1 and P2, respectively. Thus, actuation of the hydraulic actuation device 18 causes the first and second brake arms 14 and 16 to move from a non-braking position or resting position to a braking position or actuated position as the first and second brake arms 14 and 16 pivot about the first and second pivot axes P1 and P2, respectively. The pivotal movements of the first and second brake arms 14 and 16 about the first and second pivot axes P1 and P2, respectively, apply a braking force to the bicycle wheel W by pinching the bicycle rim R of the bicycle wheel W.

Now, the first and second brake arms 14 and 16 will be discussed in more detail. The first and second brake arms 14 and 16 are each a rigid member made of a suitable rigid material that is typically used for bicycle brake arms. For example, the first and second brake arms 14 and 16 can be a cold-forged aluminum arm or a carbon fiber reinforced arm. As seen from the view in FIG. 1, the first brake arm 14 pivots about the first pivot axis P1 in a counterclockwise direction to contact the bicycle rim R, while the second brake arm 16 pivots about the second pivot axis P2 in a clockwise direction to contact the bicycle rim R. Thus, the first brake arm 14 pivots about the first pivot axis P1 in a clockwise direction to move away from the bicycle rim R, while the second brake arm 16 pivots about the second pivot axis P2 in a counterclockwise direction to move away from the bicycle rim R.

As seen in FIGS. 3 and 4, the first brake arm 14 basically has a first coupling portion 14a, a first actuated portion 14b and a first mounting portion 14c. The first actuated portion

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14b and the first mounting portion 14c are disposed on opposite sides of the first coupling portion 14a. The first coupling portion 14a includes the first mounting fastener 22 that is configured to be mounted to the bicycle 1. Thus, the first coupling portion 14a is configured to pivot about the first pivot axis P1. The first actuated portion 14b extends from the first coupling portion 14a, and is operatively coupled to the hydraulic actuation device 18. The first mounting portion 14c extends from the first coupling portion 14a, and is configured to mount a first friction member 26. In the first embodiment, as seen in FIG. 3, the first mounting portion 14c includes a slot (elongated opening) for adjustably attaching the first friction member 26. In the first embodiment, the first friction member 26 is a conventional brake shoe that is detachably attached to the first mounting portion 14b in a conventional manner. Basically, the first friction member 26 includes a brake pad holder 26a and a brake pad or shoe 26b. The brake pad holder 26a supports the brake pad 26b, and is attached in the slot formed in the first mounting portion 14c by a mounting bolt 26c. The brake pad 26b of the first friction member 26 contacts one side of the bicycle rim R during a braking operation.

Similarly, the second brake arm 16 basically has a second coupling portion 16a, a second actuated portion 16b and a second mounting portion 16c. The second actuated portion 16b and the second mounting portion 16c are disposed on opposite sides of the second coupling portion 16a. The second coupling portion 16a includes the second mounting fastener 24 that is configured to be mounted to the bicycle 1. Thus, the second coupling portion 16a is configured to pivot about the second pivot axis P2. The second mounting portion 16c extends from the second coupling portion 16a, and is configured to mount a second friction member 28. In the first embodiment, as seen in FIG. 2, the second mounting portion 16c includes a slot (elongated opening) for adjustably attaching the second friction member 28. In the first embodiment, the second friction member 28 is a conventional brake shoe that is detachably attached to the second mounting portion 16b in a conventional manner. Basically, the second friction member 28 includes a brake pad holder 28a and a brake pad or shoe 28b. The brake pad holder 28a supports the brake pad 28b, and is attached in a slot formed in the second mounting portion 16c by a mounting bolt 28c. The brake pad 28b of the second friction member 28 contacts the other side of the bicycle rim R during a braking operation.

In the first embodiment, each of the first coupling portion 14a and the second coupling portion 16a is preferably provided with a bushing and/or bearing structure for pivotally supporting the first and second brake arms 14 and 16 on the first and second fasteners 22 and 24. Here, the first coupling portion 14a further includes a first brake arm supporting unit 30 for rotatably supporting the first brake arm 14 on the first fastener 22. Similarly, the second coupling portion 16a further includes a second brake arm supporting unit 32 for rotatably supporting the second brake arm 16 on the second fastener 24. In the first embodiment, the first and second brake arm supporting units 30 and 32 are each constructed as disclosed in U.S. Patent Application Publication No. 2013-0341129, which is assigned to Shimano, Inc.

Referring to FIGS. 5, 6 and 8, the first and second brake arms 14 and 16 are each biased to their non-braking positions, which constitute resting positions of the first and second brake arms 14 and 16. In more detail, the bicycle rim brake 12 comprises a first return spring 34 and a second return spring 36. The first return spring 34 biases the first brake arm 14 about the first pivot axis P1 towards the non-braking position. The second return spring 36 biases the second brake arm 16 about the second pivot axis P2 towards the non-braking posi-

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tion. The first return spring 34 has a first end portion 34a and a second end portion 34b. The first end portion 34a of the first return spring 34 is mounted in an opening in the first brake arm 14, while the second end portion 34b is hooked onto the support member 20. Similarly, the second return spring 36 has a first end portion 36a and a second end portion 36b. The first end portion 36a of the second return spring 36 is mounted in an opening in the second brake arm 16, while the second end portion 36b is hooked onto the support member 20.

Still referring to FIGS. 5, 6 and 8, the support member 20 includes a cross member 40. The cross member 40 of the support member 20 is coupled to the first and second coupling portions 14a and 16a, and maintains the first and second pivot axes P1 and P2 at a prescribed distance D apart from each other as seen in FIG. 6. The cross member 40 has a first opening 40a for receiving the first mounting fastener 22 therethrough, and a second opening 40b for receiving the second mounting fastener 24 therethrough.

The support member 20 further includes a holder 42. The holder 42 is supported on the rear side of the cross member 40. Here, a screw 44 is provided to attach the holder 42 to the cross member 40. The cross member 40 and the holder 42 are each a rigid member that is made of a suitable rigid material such that as aluminum or carbon fiber. In the first embodiment, the cross member 40 and the holder 42 are separate pieces. However, the cross member 40 and the holder 42 can be formed as a one-piece member of a single unitary material.

As explained below, the holder 42 is configured to support the hydraulic actuation device 18 on the first and second brake arms 14 and 16 via the cross member 40 with a toolless connection so that the hydraulic actuation device 18 can be removed and reinstalled from the holder 42. In this way, the hydraulic actuation device 18 can be removed from the holder 42 and then reinstalled without detaching the first and second brake arms 14 and 16 from the front fork 2.

As seen in FIGS. 6 and 8, a mounting boss 46 extends from the rear side of the cross member 40 into a mounting opening 42a of the holder 42. The mounting boss 46 has a threaded bore 46a. The screw 44 is screwed into the threaded bore 46a for attaching the holder 42 to the cross member 40. Also an anti-rotation protrusion 48 extends from the rear side of the cross member 40 and engages an anti-rotation opening 42b of the holder 42. The holder 42 includes a recess 42c that receives the hydraulic actuation device 18. As explained below, the hydraulic actuation device 18 is snap-fitted into and out of the recess 42c for installing and detaching the hydraulic actuation device 18 with respect to the first and second brake arms 14 and 16.

As seen in FIGS. 6 and 8, the rear side of the cross member 40 has a first spring attachment projection 50 and a second spring attachment projection 52. The first spring attachment projection 50 is a headed pin for attaching the second end portion 34b of the first return spring 34. In the first embodiment, the biasing forces of the first and second return springs 34 and 36 are adjustable. Specifically, the first spring attachment projection 50 is provided with a threaded hole 50a. The threaded hole 50a threadedly receives a first adjustment member 54 that is arranged to adjust a biasing force of the first return spring 34. The second spring attachment projection 52 is a headed pin for attaching the second end portion 36b of the second return spring 36. The second spring attachment projection 52 is provided with a threaded hole 52a. The threaded hole 52a threadedly receives a second adjustment member 56 that is arranged to adjust a biasing force of the second return spring 36 independently of the first adjustment member 54. In the first embodiment, the first and second adjustment members 54 and 56 are set screws. By independently screwing in

or unscrewing the first and second adjustment members **54** and **56** a user can independently adjust the biasing forces of the first and second return springs **34** and **36**. However, the first and second adjustment members **54** and **56** can have other configurations such as cams that independently rotate on the first and second spring attachment projections **50** and **52** for change the position of the first and second end portions **34b** and **36b** of the first and second return springs **34** and **36**.

Now, the hydraulic actuation device **18** will be described in more detail. Basically, the hydraulic actuation device **18** is supported on the support member **20**, and is operatively coupled to the first and second actuated portions **14b** and **16b** of the first and second brake arms **14** and **16**. The hydraulic hose **H** is connected between a conventional hydraulic actuating device (e.g., a brake lever), which is not shown, and the hydraulic actuation device **18**. The hydraulic hose **H** supplies hydraulic fluid to the hydraulic actuation device **18** in response to operation of the conventional hydraulic actuating device (e.g., a brake lever).

As seen in FIG. **11**, the hydraulic actuation device **18** includes a cylinder housing **60**, a first piston **61** and a second piston **62**. The cylinder housing **60** defines a hydraulic chamber **64**. The first piston **61** is movably disposed in the hydraulic chamber **64**. The hydraulic chamber **64** includes a first chamber **64a**, a second chamber **64b** and a third chamber **64c**. The first chamber **64a** has the first piston **61** disposed therein. The second chamber **64b** has the second piston **62** disposed therein. The third chamber **64c** is provided between the first and second chambers **64a** and **64b**. The third chamber **64c** has smaller diameter than the first and second chambers **64a** and **64b**. With this arrangement, the hydraulic hose **H** supplies hydraulic fluid to the third chamber **64c** to simultaneously actuate the first and second pistons **61** and **62**.

The exterior dimensions of the cylinder housing **60** are such that the cylinder housing **60** snaps into and out of the recess **42c** of the holder **42**. In this way, the hydraulic actuation device **18** can be removed and reinstalled with respect to the first and second brake arms **14** and **16** without a tool. In particular, the holder **42** is configured to have elasticity such that the cylinder housing **60** is snap-fitted into the recess of the holder **42**. In other words, the exterior of the cylinder housing **60** is dimensioned slightly larger than the opening of the recess **42c** of the holder **42**. As a result, the holder **42** elastically deformed as the cylinder housing **60** of the hydraulic actuation device **18** is push into the recess **42c** of the holder **42** or pulled out of the recess **42c** of the holder **42**. In this way, the recess **42c** of the holder **42** receives the cylinder housing **60** of the hydraulic actuation device **18**, and is retained in the recess **42c** of the holder **42**.

The first piston **61** is movably disposed in the hydraulic chamber **64**. The first piston **61** is operatively coupled to the first actuated portion **14b** of the first brake arm **14**. In particular, the hydraulic actuation device **18** includes a first connecting rod **66** that connects the first actuated portion **14b** of the first brake arm **14** to the first piston **61**. Thus, the first actuated portion **14b** of the first brake arm **14** is operatively coupled to the first piston **61** via the first connecting rod **66**. The second piston **62** is movably disposed in the hydraulic chamber **64**. The second piston **62** is operatively coupled to the second actuated portion **16b** of the second brake arm **16**. In particular, the hydraulic actuation device **18** includes a second connecting rod **68** that connects the first actuated portion **16b** of the second brake arm **16** to the second piston **62**. Thus, the second actuated portion **16b** of the second brake arm **16** is operatively coupled to the second piston **62** via the second connecting rod **68**.

As mentioned above, the first return spring **34** biases the first brake arm **14** about the first pivot axis **P1** towards the first piston **61**. Thus, the first connecting rod **66** applies a pushing force on the first piston **61** as a result of the biasing force of the first return spring **30** acting on the first brake arm **14**. As also mentioned above, the second return spring **36** biases the second brake arm **16** about the second pivot axis **P2** towards the second piston **62**. Thus, the second connecting rod **68** applies a pushing force on the second piston **62** as a result of the biasing force of the second return spring **32** acting on the second brake arm **16**.

As seen in FIGS. **9** to **11**, the first connecting rod **66** has a first end portion **66a** that is connected to the first piston **61** and a second end portion **66b** that is connected to the first actuated portion **14b**. The first end portion **66a** of the first connecting rod **66** is configured to be pivotally and detachably coupled to the first piston **61**. In the first embodiment, the first end portion **66a** of the first connecting rod **66** includes a partially spherical part or ball that is received in a recess or socket **61a** of the first piston **61**. The first connecting rod **66** is pivotally connected to the first brake arm **14**. The first connecting rod **66** includes a first pivot pin **70** that is disposed in a first socket **14b1** of the first actuated portion **14b** of the first brake arm **14**. The first connecting rod **66** is adjustably connected to the first brake arm **14**. In the first embodiment, the second end portion **66b** of the first connecting rod **66** is threaded. The second end portion **66b** is screwed into a threaded hole **70a** of the first pivot pin **70** for adjustably coupling the first connecting rod **66** to the first brake arm **14**. The end of the second end portion **66b** has a tool receiving recess for rotating the first connecting rod **66** to adjust the resting position of the first brake arm **14**. In this way, the first connecting rod **66** is configured to remain attached to the first brake arm **14** in a state where the hydraulic actuation device **18** is removed.

As seen in FIGS. **9** to **11**, the second connecting rod **68** has a first end portion **68a** that is connected to the second piston **62** and a second end portion **68b** that is connected to the second actuated portion **16b**. The second connecting rod **68** is pivotally connected to the second brake arm **16**. The first end portion **68a** of the second connecting rod **68** is configured to be pivotally and detachably coupled to the second piston **62**. In the first embodiment, the first end portion **68a** of the second connecting rod **68** includes a partially spherical part or ball that is received in a recess or socket **61a** of the second piston **62**. The second connecting rod **68** includes a second pivot pin **72** that is disposed in a second socket **16b1** of the second actuated portion **16b** of the second brake arm **16**. The second connecting rod **68** is adjustably connected to the second brake arm **16**. In the first embodiment, the second end portion **68b** of the second connecting rod **68** is threaded. The second end portion **68b** is screwed into a threaded hole **72a** of the second pivot pin **72** for adjustably coupling the second connecting rod **68** to the second brake arm **16**. The end of the second end portion **68b** has a tool receiving recess for rotating the second connecting rod **68** to adjust the resting position of the second brake arm **16**. In this way, the second connecting rod **68** is configured to remain attached to the second brake arm **16** in a state where the hydraulic actuation device **18** is removed.

As seen in FIGS. **11** and **16**, the cylinder housing **60** includes an inlet bore **74** fluidly communicating with the hydraulic chamber **64** at a location between the first and second pistons **61** and **62**. In particular, the inlet bore **74** fluidly communicates with the third chamber **64c** of the hydraulic chamber **64** to supply hydraulic fluid thereto for moving the first and second pistons **61** and **62** within the first and second chamber **64a** and **64b** of the hydraulic chamber **64**. The first and second pistons **61** and **62** are movable along

an actuation axis A1 of the hydraulic chamber 64. The inlet bore 74 has a center longitudinal axis A2 that is perpendicularly arranged with respect to the actuation axis A1 of the hydraulic chamber 64.

As seen in FIGS. 11 to 14, the hydraulic actuation device 18 includes a first sealing member 81 that is provided on the cylinder housing 60 so as to at least partially support the first piston 61 in the hydraulic chamber 64. As seen in FIG. 11, the hydraulic actuation device 18 includes a second sealing member 82 that is provided on the cylinder housing 60 so as to at least partially support the second piston 62 in the hydraulic chamber 64. The first and second sealing members 81 and 82 are identical in the first embodiment. The cylinder housing 60 has a first annular recess 60a and a second annular recess 60b. The first sealing member 81 is disposed in the first annular recess 60a and protrudes from the first annular recess 60a so as to support the first piston 61. The second sealing member 82 is disposed in the second annular recess 60b and protrudes from the second annular recess 60b so as to support the second piston 62. The first and second annular recesses 60a and 60b are identical, except that they are mirror images in the first embodiment. The first and second annular recesses 60a and 60b are provided with sufficient axial dimensions so that the first and second sealing members 81 and 82 can deflect in the axial direction along the actuation axis A1 during movement of the first and second pistons 61 and 62 before contacting the cylinder housing 60. The first annular recess 60a has a trapezoidally shaped cross-sectional profile which has a first outer surface 60a1 that expands in diameter as the first outer surface 60a1 approaches toward the first actuated portion 14b of the first brake arm 14. The second annular recess 60b has a trapezoidally shaped cross-sectional profile which has a second outer surface 60b1 that expands in diameter as the second outer surface 60b1 approaches toward the second actuated portion 16b of the second brake arm 16. Thus, the first and second outer surfaces 60a1 and 60b1 are angled with respect to the actuation axis A1 such that the outer diameters of the first and second annular recesses 60a and 60b increases the farther that the first and second annular recesses 60a and 60b are from the center longitudinal axis A2 of the inlet bore 74. The phrase “trapezoidal shaped cross-sectional profile” as used herein with respect to the first and second annular recesses 60a and 60b refers to an overall shape of each recess as being trapezoidal with two parallel and two nonparallel sides, and in which the corners can be rounded and/or cutoff at an angle as well as one or more of the sides be non-planar.

The first sealing member 81 is made of a flexible, resilient or elastic material such as a rubber material suitable for hydraulic applications. The second sealing member 82 is made of an elastic material that is the same as the first sealing member 81. The first and second sealing members 81 and 82 create seals between the cylinder housing 60 and the first and second pistons 61 and 62 to prevent hydraulic fluid from leaking out of the hydraulic chamber 64 past the first and second pistons 61 and 62. The first sealing member 81 is an O-ring having a rectangularly shaped cross-sectional profile with a cylindrical inner surface 81a contacting the first piston 61. The second sealing member 82 is an O-ring having a rectangularly shaped cross-sectional profile with a cylindrical inner surface 82a contacting the second piston 62. The phrase “cross-sectional profile” as used herein with respect to the first and second sealing members 81 and 82 refers to just a transverse cross section of a segment of the sealing members as shown in cross section in FIGS. 12 to 14. The phrase “cross-sectional profile” as used herein with respect to the first and second sealing members 81 and 82 does not refer to a transverse cross section of the entire sealing member. The

phrase “rectangularly shaped” as used herein with respect to the first and second sealing members 81 and 82 refers to an overall shape that is rectangular having four planar sides with opposite sides being parallel, and in which the corners can be rounded and/or cutoff at an angle.

Referring to FIGS. 12 to 14, the first and second sealing members 81 and 82 are configured to provide an automatic adjustment of the brake pad clearances between the bicycle rim R and the brake pads 26b and 28b after actuation of the bicycle rim brake 12. In particular, after actuation when the brake lever returns to a rest position, the first and second sealing members 81 and 82 return the first and second pistons 61 and 62 back to their initial positions thereby providing a running clearance between the bicycle rim R and the brake pads 26b and 28b. More specifically, when the first piston 61 is moved axially in the hydraulic chamber 64 along the actuation axis A1 from a resting position (FIG. 12) to an actuated position (FIG. 13), the first sealing member 81 is deflected in the axial direction as seen in FIG. 13. In the actuated position of FIG. 13, the first sealing member 81 is temporarily deformed. The resulting deformation of the first sealing member 81 results in the first sealing member 81 applying a piston restoring force on the first piston 61. Thus, once the hydraulic pressure is reduced in the hydraulic chamber 64, the first sealing member 81 will act on the first piston 61 to return the first piston 61 to the resting position as seen in FIG. 12.

Before any wear occurs in the brake pads 26b and 28b, movement of the first piston 61 causes the first sealing member 81 to deflect but the first piston 61 does not slide on the first sealing member 81. Upon wear occurring in the brake pads 26b and 28b, actuation of the first piston 61 will result in the first sealing member 81 to be first deflected and then the first piston 61 will slide on the first sealing member 81 to counteract the wear in the brake pads 26b and 28b. Thus, a new resting position is established when the first sealing member 81 acts on the first piston 61 to return the first piston 61 to the resting position. The second sealing member 82 operates in the same way as the first sealing member 81.

In understanding the scope of the present invention, the term “comprising” and its derivatives, as used herein, are intended to be open ended terms that specify the presence of the stated features, elements, components, groups, integers, and/or steps, but do not exclude the presence of other unstated features, elements, components, groups, integers and/or steps. The foregoing also applies to words having similar meanings such as the terms, “including”, “having” and their derivatives. Also, the terms “part,” “section,” “portion,” “member” or “element” when used in the singular can have the dual meaning of a single part or a plurality of parts unless otherwise stated.

As used herein, the following directional terms “frame facing side”, “non-frame facing side”, “forward”, “rearward”, “front”, “rear”, “up”, “down”, “above”, “below”, “upward”, “downward”, “top”, “bottom”, “side”, “vertical”, “horizontal”, “perpendicular” and “transverse” as well as any other similar directional terms refer to those directions of a bicycle in an upright, riding position and equipped with the bicycle rim brake. Accordingly, these directional terms, as utilized to describe the bicycle rim brake should be interpreted relative to a bicycle in an upright riding position on a horizontal surface and that is equipped with the bicycle rim brake. The terms “left” and “right” are used to indicate the “right” when referencing from the right side as viewed from the rear of the bicycle, and the “left” when referencing from the left side as viewed from the rear of the bicycle.

Also it will be understood that although the terms “first” and “second” may be used herein to describe various compo-

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nents these components should not be limited by these terms. These terms are only used to distinguish one component from another. Thus, for example, a first component discussed above could be termed a second component and vice versa without departing from the teachings of the present invention. The term “attached” or “attaching”, as used herein, encompasses configurations in which an element is directly secured to another element by affixing the element directly to the other element; configurations in which the element is indirectly secured to the other element by affixing the element to the intermediate member(s) which in turn are affixed to the other element; and configurations in which one element is integral with another element, i.e. one element is essentially part of the other element. This definition also applies to words of similar meaning, for example, “joined”, “connected”, “coupled”, “mounted”, “bonded”, “fixed” and their derivatives. Finally, terms of degree such as “substantially”, “about” and “approximately” as used herein mean an amount of deviation of the modified term such that the end result is not significantly changed.

While only selected embodiments have been chosen to illustrate the present invention, it will be apparent to those skilled in the art from this disclosure that various changes and modifications can be made herein without departing from the scope of the invention as defined in the appended claims. For example, unless specifically stated otherwise, the size, shape, location or orientation of the various components can be changed as needed and/or desired so long as the changes do not substantially affect their intended function. Unless specifically stated otherwise, components that are shown directly connected or contacting each other can have intermediate structures disposed between them so long as the changes do not substantially affect their intended function. The functions of one element can be performed by two, and vice versa unless specifically stated otherwise. The structures and functions of one embodiment can be adopted in another embodiment. It is not necessary for all advantages to be present in a particular embodiment at the same time. Every feature which is unique from the prior art, alone or in combination with other features, also should be considered a separate description of further inventions by the applicant, including the structural and/or functional concepts embodied by such feature(s). Thus, the foregoing descriptions of the embodiments according to the present invention are provided for illustration only, and not for the purpose of limiting the invention as defined by the appended claims and their equivalents.

What is claimed is:

1. A bicycle rim brake comprising:

- a first brake arm having a first coupling portion, a first actuated portion and a first mounting portion, the first coupling portion including a first mounting fastener that is configured to be mounted to a bicycle and that defines a first pivot axis of the first brake arm, the first mounting portion being configured to mount a first friction member and extending from the first coupling portion;
- a second brake arm having a second coupling portion; a second actuated portion and a second mounting portion, the second coupling portion including a second mounting fastener that is configured to be mounted to a bicycle and that defines a second pivot axis of the first brake arm, the second mounting portion being configured to mount a second friction member and extending from the second coupling portion; and
- a hydraulic actuation device including a cylinder housing defining a hydraulic chamber including a first chamber, a second chamber and a third chamber provided between the first and second chambers, the hydraulic actuation

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device further including a first piston movably disposed in the first chamber of the hydraulic chamber and operatively coupled to the first actuated portion of the first brake arm, and a second piston movably disposed in the second chamber of the hydraulic chamber and operatively coupled to the second actuated portion of the second brake arm.

2. The bicycle rim brake according to claim 1, further comprising

- a first return spring biasing the first brake arm about the first pivot axis towards the first piston.

3. The bicycle rim brake according to claim 2, further comprising

- a second return spring biasing second brake arm about the second pivot axis towards the second piston.

4. The bicycle rim brake according to claim 3, further comprising

- a first adjustment member arranged to adjust a biasing force of the first return spring and a second adjustment member arranged to adjust a biasing force of the second return spring.

5. The bicycle rim brake according to claim 1, wherein the cylinder housing includes an inlet bore fluidly communicating with the hydraulic chamber at a location between the first and second pistons.

6. The bicycle rim brake according to claim 5, wherein the first and second pistons are movable along an actuation axis of the hydraulic chamber, and the inlet bore has a center longitudinal axis that is perpendicularly arranged with respect to the actuation axis of the hydraulic chamber.

7. The bicycle rim brake according to claim 1, further comprising

- a first connecting rod having a first end portion connected to the first piston and a second end portion connected to the first actuated portion; and
- a second connecting rod having a first end portion connected to the second piston and a second end portion connected to the second actuated portion.

8. The bicycle rim brake according to claim 7, wherein the first end portion of the first connecting rod is configured to be pivotally coupled to the first piston, and the first end portion of the second connecting rod is configured to be pivotally coupled to the second piston.

9. The bicycle rim brake according to claim 1, further comprising

- a support member coupled to the first and second coupling portions and maintaining the first and second pivot axes at a prescribed distance apart from each other.

10. The bicycle rim brake according to claim 9, wherein the hydraulic actuation device is mounted on the support member.

11. The bicycle rim brake according to claim 1, wherein the first actuated portion and the first mounting portion are disposed on opposite sides of the first coupling portion, and the second actuated portion and the second mounting portion are disposed on opposite sides of the second coupling portion.

12. The bicycle rim brake according to claim 1, wherein the third chamber has a smaller diameter than the first and second chambers.

13. A bicycle rim brake comprising:

- a first brake arm having a first coupling portion, a first actuated portion and a first mounting portion, the first coupling portion including a first mounting fastener that is configured to be mounted to a bicycle and that defines

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- a first pivot axis of the first brake arm, the first mounting portion being configured to mount a first friction member and extending from the first coupling portion;
- a second brake arm having a second coupling portion, a second actuated portion and a second mounting portion, the second coupling portion including a second mounting fastener that is configured to be mounted to a bicycle and that defines a second pivot axis of the first brake arm, the second mounting portion being configured to mount a second friction member and extending from the second coupling portion;
- a hydraulic actuation device including a cylinder housing defining a hydraulic chamber, a first piston movably disposed in the hydraulic chamber and operatively coupled to the first actuated portion of the first brake arm, and a second piston movably disposed in the hydraulic chamber and operatively coupled to the second actuated portion of the second brake arm;
- a support member coupled to the first and second coupling portions;
- a first return spring having a first end coupled to the first brake arm and a second end coupled to the support member, the first return spring biasing the first brake arm about the first pivot axis towards the first piston; and
- a first adjustment member arranged to adjust a biasing force of the first return spring at the second end of the first return spring at a location spaced from the first pivot axis.
- 14.** The bicycle rim brake according to claim **13**, further comprising

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- a second return spring having a first end coupled to the second brake arm and a second end coupled to the support member, the second return spring biasing the second brake arm about the second pivot axis towards the second piston.
- 15.** The bicycle rim brake according to claim **14**, further comprising
- a second adjustment member arranged to adjust a biasing force of the second return spring at the second end of the second return spring at a location spaced from the second pivot axis.
- 16.** The bicycle rim brake according to claim **15**, wherein the second end of the second return spring is coupled to a second spring attachment projection of the support member, the second adjustment member is adjustably arranged in a hole of the second spring attachment projection.
- 17.** The bicycle rim brake according to claim **16**, wherein the second adjustment member is adjustably arranged in the hole of the second spring attachment projection in a direction perpendicular to the second pivot axis.
- 18.** The bicycle rim brake according to claim **13**, wherein the second end of the first return spring is coupled to a first spring attachment projection of the support member, the first adjustment member is adjustably arranged in a hole of the first spring attachment projection.
- 19.** The bicycle rim brake according to claim **18**, wherein the first adjustment member is adjustably arranged in the hole of the first spring attachment projection in a direction perpendicular to the first pivot axis.

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